Hydraulic conductivity values were specified as a function of grain size distribution ranging from 2 ft/day for fine-grain sediments to 45 ft/day for coarse-grain sediments. The hydraulic conductivity of weathered granitic rocks was specified as 0.2 ft/day. Specified leakance values allowed for simulation of vertical flow in the model domain. Values of effective vertical hydraulic conductivity incorporated into the leakance term were less than 0.1 times the value of horizontal hydraulic conductivity.

Lake Tahoe was simulated using a constant head boundary specified as 6226 ft MSL. The lake boundary was specified to be a vertical plane. The conductance of lakebed sediments was not addressed. Streams were represented using the MODFLOW River Package. This algorithm requires the specification of stream stage, and allows for specification of riverbed sediment conductance. The algorithm does not simulate stream flow. The Tahoe Keys were also represented using the MODFLOW River Package. The southern model boundary south of the airport was simulated using a constant head boundary. Outcrops on the east and west sides of the site were simulated using specified flux boundaries. Recharge to groundwater from precipitation and snowmelt was assigned to be 25% of surface recharge. The model was calibrated under steady-state and transient conditions. Model results were used to estimate the effects of increased South Tahoe Public Utilities District pumping in the alluvial aquifer near Lake Tahoe.

4. DATA ANALYSIS

4.1 Surface of Lakebed Sediments

Previous models (Woodling,1987; AGRA,1999) represented the lake as a vertical boundary. However, analysis of the bathymetric surface indicates that the lakebed slopes gently away from the shoreline, especially at shallow depths. The depth of aquifer sediments at the shoreline ranges from 400 to 1,000 ft. The elevation of the lakebed surface decreases as little as 25 ft over a distance of 2,000 ft away from the shoreline. In deeper sediments, the location of the lake-groundwater interface is as great as 8,000 ft beyond the shoreline.

4.2 Fluctuations in Lake and Groundwater Elevations

Lake and groundwater elevations do not appear to vary greatly on a seasonal basis. Rather, lake and groundwater elevations show a rising trend during multi-year periods of above average precipitation and a declining trend during drought periods. Loeb et al. (1987) noted that lake and groundwater elevation differences were fairly consistent throughout most years. This "rough correlation between groundwater level and lake level changes made a steady-state model for this basin more credible." (Loeb et al., 1987) Between 1957 and 2002, lake elevation varied from a high of 6228.1 ft MSL and a low of 6219.1 ft MSL. The average lake elevation during this period was 6225.0 ft MSL.

4.3 Stream Flow Data

The U.S. Geological Survey (USGS) maintains six continuous gage stations on the Upper Truckee River and Trout Creek. Three of these stations are in the study area. Stream flows vary greatly seasonally, with high stream flows generally during March and April, and low stream flows generally during September and October. The 1996-2002 average flow of the Upper Truckee River at the I-50 crossing was 90 ft^3/sec. The 1996-2002 average flow of Trout Creek at Martin Avenue was 36 ft^3/sec. The MSL elevation of these stations has been surveyed.

From 1996 to 2000, the USGS conducted annual stream-flow measurements on the Upper Truckee River and Trout Creek under low-conditions in the fall of each year. These studies provided information on the location and rate of water exchange between the streams and the adjacent aquifer. Rowe and Allandar (1996) provide September 1996 stream flow measurement data and seepage estimates at 63 locations. Results of this study indicate the Upper Truckee River is generally steady or gaining slightly throughout the model domain. Trout Creek loses slightly during low flow periods, except between the Cold Creek and Heavenly Creek confluences, where it gains slightly.

4.4 Pumping Well Data

Pumping wells have a direct effect on groundwater flow gradients near Lake Tahoe. A significant amount of pumped water has the lake or adjacent streams as its source. There are nine major pumping wells in the model domain. Total pumping from these wells averaged 844,000 ft^3/day (4,380 gpm) between 1996 and 2002. The two most prominent pumping wells in the model domain, the Al Tahoe and Paloma wells, provide the municipal water supply for the city of South Lake Tahoe (Figure 1). The average (1996-2002) groundwater extraction rates by the Al Tahoe and Paloma wells are 360,000 ft^3/day (1,870 gpm) and 145,000 ft^3/day (750 gpm) respectively. The Al Tahoe well is located about 1,400 ft from the lake shoreline. However, the deep aquifer the well is screened in interfaces with the lakebed a distance of about 5,000 ft from the well. The Paloma well is located about 3,200 ft from the lake shoreline, and about 600 ft from Trout Creek and 1,200 ft from the Upper Truckee River. Another pumping well which effects lake-groundwater interaction is the Valhalla well located at the western end of the model domain, about 1,200 ft from the lake shoreline. The Valhalla well pumps at an average (1999-2002) rate of 49,000 ft^3/day (260 gpm).

4.5 Selection of Calibration Dates

Model calibration requires data on groundwater levels, stream flows, lake elevation, recharge from precipitation and snowmelt, and groundwater pumping. As a result of data analysis, it was determined that the dates fall 1996 and spring 2002 provide the most complete representation of site conditions.

5. DEVELOPMENT OF GROUNDWATER FLOW MODEL